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Research Article

Twenty-three new synonyms of the Eastern common groundhopper, *Tetrix japonica* (Bolívar, 1887) (Orthoptera, Tetrigidae)

Ying Long[1], Caili Teng[1], Chaomei Huang[1], Rongjiao Zhang[2], Weian Deng[1,2,3,4], Liliang Lin[5]

1 *Key Laboratory of Ecology of Rare and Endangered Species and Environmental Protection (Guangxi Normal University), Ministry of Education, Guilin, Guangxi 541006, China*
2 *School of Chemistry and Bioengineering, Hechi University, Yizhou, Guangxi 546300, China*
3 *Guangxi Key Laboratory of Rare and Endangered Animal Ecology, Guangxi Normal University, Guilin, Guangxi 541006, China*
4 *College of Life Science, Guangxi Normal University, Guilin, Guangxi 541004, China*
5 *College of Life Sciences, Shaanxi Normal University, Xi'an, Shaanxi 710062, China*
Corresponding authors: Rongjiao Zhang (zhangrongjiao0922@163.com); Weian Deng (dengweian5899@163.com)

Abstract

The Eastern common groundhopper, *Tetrix japonica*, is a pygmy grasshopper species widely distributed in the Eastern Palearctic region, and shows a high degree of phenotypic variation. The classification of *Tetrix japonica* is difficult and frequently involved errors. Among the many species of Tetrigidae that have been described in China within the last decades, many synonyms of *Tetrix japonica* were found. The type specimens of many species deposited in the Chinese museums have been re-examined and as a result, *Tetrix japonica* is systematically revised. Based on the results of this review, 23 new synonyms of *Tetrix japonica* are proposed: *Coptotettix circinihumerus* Zheng & Deng, 2004, **syn. nov.**; *Coptotettix emeiensis* Zheng, Lin & Zhang, 2012, **syn. nov.**; *Euparatettix rongshuiensis* Zheng, 2005, **syn. nov.**; *Euparatettix zayuensis* Zheng, Zeng & Ou, 2011, **syn. nov.**; *Macromotettix nigritubercle* Zheng & Jiang, 2006, **syn. nov.**; *Macromotettix yaoshanensis* Zheng & Jiang, 2000, **syn. nov.**; *Tetrix albistriatus* Yao & Zheng, 2006, **syn. nov.**; *Tetrix albomaculatus* Zheng & Jiang, 2006, **syn. nov.**; *Tetrix albomarginis* Zheng & Nie, 2005, **syn. nov.**; *Tetrix cenwanglaoshana* Zheng, Jiang & Liu, 2005, **syn. nov.**; *Tetrix cliva* Zheng & Deng, 2004, **syn. nov**.; *Tetrix duolunensis* Zheng, 1996, **syn. nov.**; *Tetrix grossovalva* Zheng, 1994, **syn. nov.**; *Tetrix jiuwanshanensis* Zheng, 2005, **syn. nov.**; *Tetrix latipalpa* Cao & Zheng, 2011, **syn. nov.**; *Tetrix liuwanshanensis* Deng, Zheng & Wei, 2007, **syn. nov.**; *Tetrix qinlingensis* Zheng, Huo & Zhang, 2000, **syn. nov.**; *Tetrix rectimargina* Zheng & Jiang, 2004, **syn. nov.**; *Tetrix ruyuanensis* Liang, 1998, **syn. nov.**; *Tetrix xianensis* Zheng, 1996, **syn. nov.**; *Tetrix xinchengensis* Deng, Zheng & Wei, 2007, **syn. nov.**; *Tetrix yunlongensis* Zheng & Mao, 2002, **syn. nov.**; *Tetrix zhoushanensis* Gao, Liu & Yin, 2022, **syn. nov.** It is expected that there will be the discoveries of more synonyms of this and other Tetriginae species from the Eastern Palearctic.

Key words: China, *Coptotettix*, *Euparatettix*, *Macromotettix*, taxonomy, Tetriginae

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Introduction

The Eastern groundhopper, *Tetrix japonica* (Bolívar, 1887), is widely distributed in East Asia (China, Japan, North Korea, and Russia), and may be also present in Mongolia, Myanmar, Laos, and Vietnam. It is a very common species in China. *Tetrix japonica* inhabits many different habitat types, from low grassland areas with moss to higher elevation areas such as hills and mountains. Its main foods are tender mosses and humus. *Tetrix japonica* is a dimorphic species from the standpoint of wings and pronotum length (Deng 2021; Zhang et al. 2022). Within the same population, *T. japonica* can have brachypronotal and brachypterous individuals (Fig. 1A, B), macropronotal, and pauropronotal individuals (Fig. 1C). Brachypronotal and brachypterous individuals are those that have a short pronotum and hind wings. Their pronotum generally does not reach the apex of the hind femur and their hind wings do not reach or only slightly surpass the apex of the hind pronotal process. Macropronotal individuals are these with pronotum longer than the apex of the hind femur, but whose wings do not exceed the tip of the pronotum, while pauropronotal individuals are those with a prolonged pronotum and hind wings. The pronotum reaches the middle of the hind tibia and their hind wings extend beyond the pronotal apex (Devriese et al. 2023) and nearly reach the apex of the hind tibia.

Many new species of Tetrigidae have been described from China in the past (Liang and Zheng 1998; Zheng 2005a; Deng et al. 2007a; Deng 2016; Cigliano et al. 2022); however, many of them are known only from the type material and never recorded again. Tetriginae are an especially complicated subfamily from the standpoint of taxonomy, as its members lack most of clear traits present in other Tetrigidae subfamilies (Skejo and Gupta 2015; Tumbrinck 2019; Kasalo et al. 2023). Revisionary studies have recently discovered that species of some genera were described without clear traits (Adžić et al. 2020; Lu and Zha 2020; Wei and Deng 2023).

Because of the aforementioned, the aim of this study was to revise the type material deposited in the natural history museums of China and find which were *Tetrix japonica* described under different names: we present 23 newly discovered synonyms of this species and analyze the probable causes of the description of so many synonyms. The goals include the determination of species variability and establishment of a good taxonomic practice (Lehmann et al. 2017) in Tetrigidae identification of species found in China.

Materials and methods

Taxonomy, nomenclature, terminology, and measurements

Taxonomy follows Orthoptera Species File [OSF] (Cigliano et al. 2022), a database of Orthoptera taxonomy. Nomenclature is in accordance with the International Code of the Zoological Nomenclature (ICZN 1999). Morphological terminology and landmark-based measurement method followed those used by Zheng (2005a), Deng et al. (2007a), Tumbrinck (2014, 2019), Muhammad et al. (2018), Tan and Artchawakom (2015), Devriese et al. (2023), and Zha et al. (2020). Measurements are given in millimeters (mm).

Photography

Grasshopper specimens were examined using a Motic-SMZ-168 stereo-microscope and photographed using a KEYENCE VHX-600 Digital Microscope. All images were processed with Adobe photoshop CS 11.0.

Type specimen depositories

The specimens examined in this study, including all holotypes and paratypes, have been deposited in the following institutions:

BMSYU Biology Museum of Sun Yat-sen University, Guangzhou, PR China;
CLSGNU College of Life Science, Guangxi Normal University, Guilin, China;
EMHU Entomological Museum of Hechi University, Hechi, China;
IZSNU Institute of Zoology, Shaanxi Normal University, Xi'an, China;
MHNG Muséum d'histoire naturelle, Geneve, Switzerland;
MHU Museum of Hebei University, Baoding, China.

Results

***Tetrix japonica* (Bolívar, 1887)**

Tettix japonicus: Bolívar, 1887: 263 [description] (holotype ♀, Japan, in MHNG).
Acrydium japonicum: Rehn 1902: 629; Kirby 1910: 45.
Tetrix japonica: Bey-Bienko 1934: 9; Bey-Bienko and Mistshenko 1951: 105; Yin 1984: 16; Blackith 1992: 183; Ichikawa 1993: 1; Paris 1993: 241; Storozhenko et al. 1994: 13; Ma and Zheng 1994: 445; Jiang and Zheng 1998: 340; Liang and Zheng 1998: 174; Kim and Kim 2004: 266; Jiang and Liang 2004: 204; Zheng 2005: 334a; Benediktov 2005; Deng et al. 2007a: 302; Tsurui Honma and Nishida 2010: 2; Cao and Zheng 2011: 738; Kim and Puskás 2012: 12; Xiao et al. 2012: 288; Zheng 2014: 56; Storozhenko et al. 2015: 167; Deng 2016: 250.

Previously reported synonyms. *Tettix longulus* Shiraki, 1906, *Tettix sibiricus* Bolívar, 1887, *Tetrix trux* Steinmann, 1964.

Link. https://orthoptera.speciesfile.org/otus/809028/overview.

Redescription. Female (Figs 1, 2). Small size and short in brachypronotal and brachypterous individuals, or medium size and long in pauropronotal individuals. Body surface smooth and interspersed with granules.

***Head*.** Head and eyes not exserted above pronotal surface. In dorsal view, fastigium of vertex short; width of vertex between eyes generally wider than width of a compound eye (1.3–1.6 ×), sometimes 1.0 × (such as *T. albistriatus* syn. nov., *T. rectimargina* syn. nov.); anterior margin of fastigium truncated or slightly arcuate and slightly surpassing anterior margin of eye; median carina visible; lateral margins slightly turned backward; depressed on either side of median carina. In lateral view, frontal ridge and vertex forming an obtuse angle; frontal costa slightly straight above antennal groove, protruded anteriorly and broadly rounded between antennal grooves. In frontal view, frontal costa

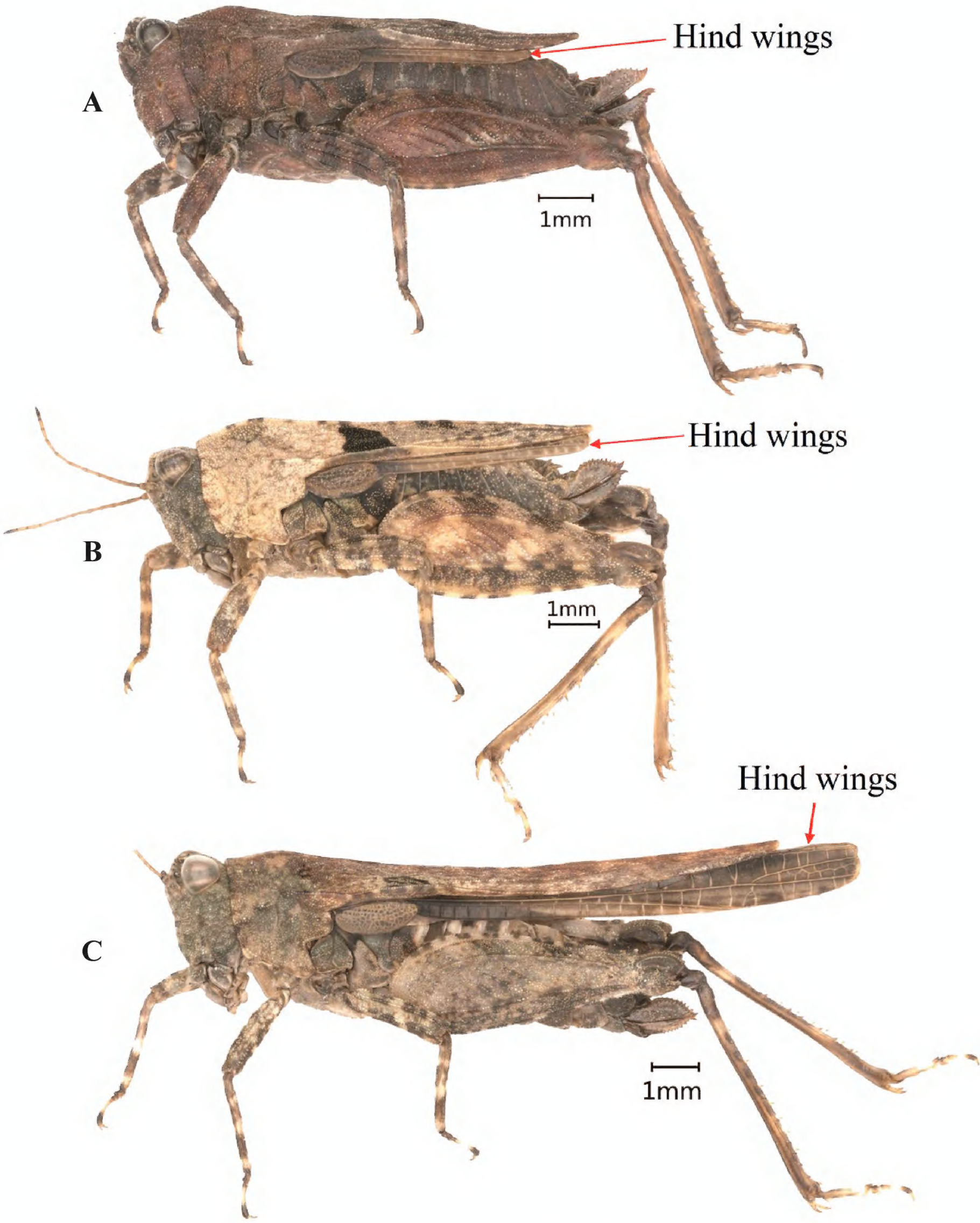


Figure 1. Dimorphism of *Tetrix japonica* (Bolívar, 1887) **A, B** brachypronotal and brachypterous individuals **C** paurop-ronotal individual.

bifurcated above lateral ocelli, longitudinal furrow divergent between antennae, width of longitudinal furrow of frontal ridge narrower than antennal groove diameter. Antennae short, filiform, antennal grooves inserted between inferior margins of compound eyes, 15-segmented (including scape, pedicel, and a

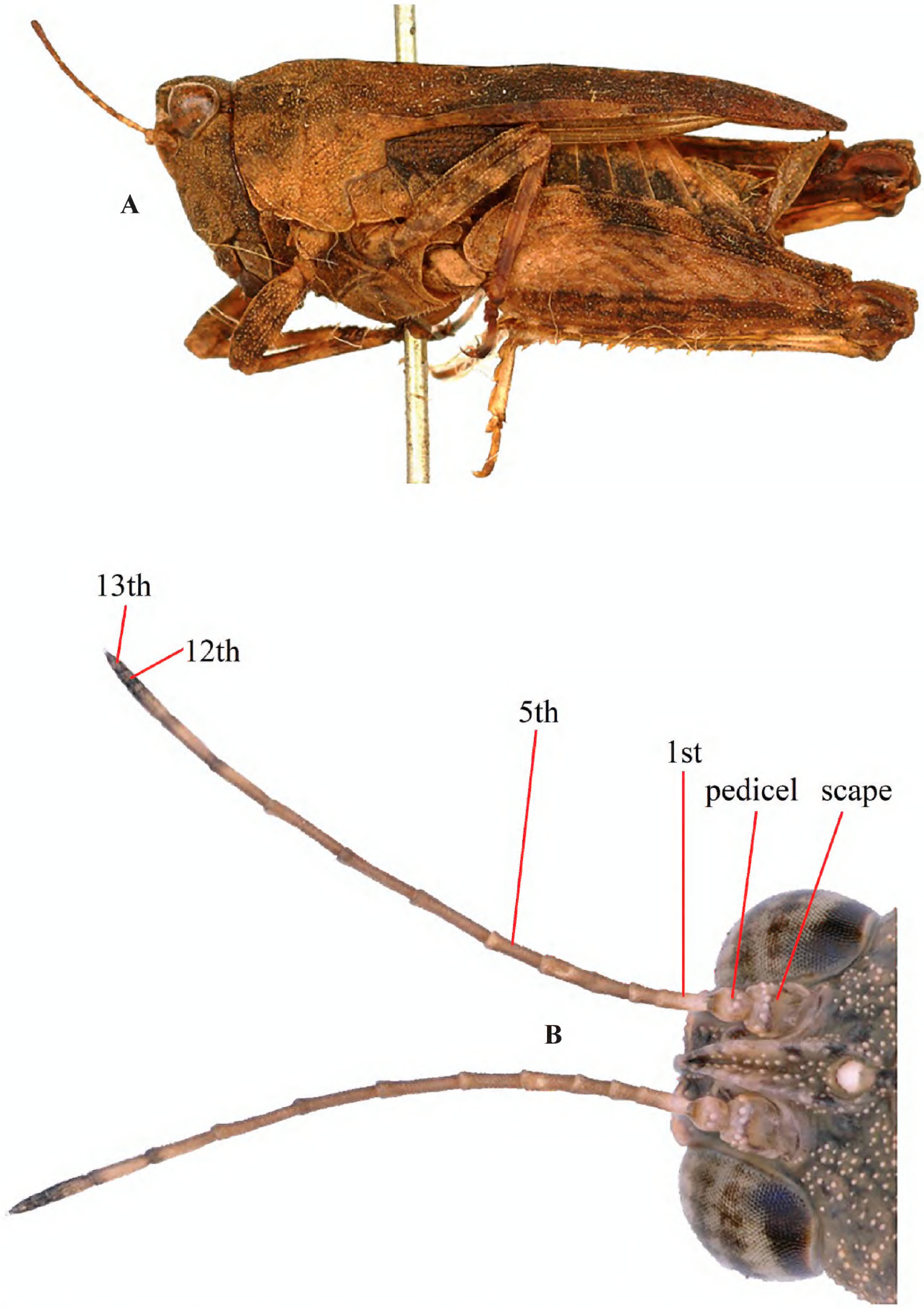


Figure 2. *Tetrix japonica* (Bolívar, 1887) **A** syntype, lateral view (photograph Josef Tumbrinck) **B** antenna, 15-segmented (including scape, pedicel, 13-segmented flagellum).

13-segmented flagellum) (Fig. 2B), the 9th and 10th segment are the longest, ~ 4–5 × longer than its width. Eyes globose, lateral (paired) ocelli located in middle of compound eye height.

Thorax. Pronotum slightly tectiform, its surface smooth and interspersed with dense granules. In dorsal view, anterior margin of pronotum generally truncate, sometimes slightly angular protruding; lateral carinae of prozona generally parallel or sometimes slightly constricted backwards; median carina low and full length entire; humeral angle obtuse; hind pronotal process narrow and long, pronotal apex either generally slightly not reaching or sometimes reaching apex of hind femur in brachypronotal and brachypterous individuals (Fig. 2C) or distinctly surpassing apex of hind femur and reaching approximately the middle of hind tibia in pauropronotal individuals (Fig. 2A, B). In profile, median carina of pronotum slightly straight or slightly arch-like before the shoulders and straight behind the shoulders. Posterior margins of lateral lobes of pronotum with ventral sinus and tegminal sinus. Posterior angles of lateral lobes turned downwards, generally narrow and rounded or sometimes subtruncately at apex. Tegmina long, ovate, apex rounded. Hind wings either slightly not reaching or reaching or slightly surpassing apex of hind pronotal process in brachypronotal and brachypterous individuals (Fig. 2C) or distinctly surpassing apex of hind pronotal process and nearly reaching of apex of hind tibia in pauropronotal individuals (Fig. 2A, B).

Legs. Fore and middle femora slightly compressed and margins finely serrated, ventral margins of middle femora straight or slightly undulated, middle femur slightly narrower than or equal to or slightly wider than visible part of tegmen in width. Hind femora robust and short, 2.8–3.4 × as long as wide; margins finely serrated; antegenicular denticles acute and genicular denticles obtuse. Outer side of hind tibia with seven or eight spines, inner side with six or seven spines. Length of first segment of posterior tarsi longer than third, three pulvilli of first segment of posterior tarsi increased in turn, apices of all pulvilli acute.

Abdomen. Ovipositor narrow and long, length of upper valvulae 3.0 × its width, upper and lower valvulae with slender saw-like teeth. Length of subgenital plate longer than its width, middle of posterior margin of subgenital plate triangularly projecting.

Coloration. Body yellow brown or brown or dark brown; antennae brown; dorsum of pronotum with two black spots behind the shoulders or with two black spots before the shoulders and behind the shoulders respectively or without black spot. Hind femora brown, outer side with two inconspicuous blackish spots in some individuals. Hind tibia yellow brown or brown or dark brown.

Male. Similar to female, but smaller and narrower. Width of vertex between eyes generally 1.2–1.5 × or sometimes equal to width of compound eye; dorsal margins straight and ventral margins of middle femora straight or slightly undulated, middle femur generally wider than or sometimes equal to visible part of tegmen in width. Subgenital plate short, cone-shaped, apex bifurcated.

Measurements (mm). See Table 1. Length of body: ♂ 6.0–10.0 (brachypronotal individuals) or 8.0–10.0 (pauropronotal individuals), ♀ 9.0–12.0 (brachypronotal individuals) or 8.5–11.0 (pauropronotal individuals); length of pronotum: ♂ 6.0–8.5 (brachypronotal individuals) or 6.0–11.0 (pauropronotal individuals), ♀ 7.5–9.0 (brachypronotal individuals) or 7.0–13.0 (pauropronotal individuals); length of hind femur: ♂ 5.0–6.0 (brachypronotal individuals) or 5.0–5.5 (pauropronotal individuals), ♀ 5.0–8.1(brachypronotal individuals) or 6.0–7.0 (pauropronotal individuals).

Table 1. Measurements for the type specimens of synonyms of *T. japonica*.

Species	V/E		LB (in mm)		LP (in mm)		LF (in mm)		M/T		LH/WH
	female	male	female	male	female	male	female	male	female	male	
*C. circinihumerus***	1.6	–	10.3	–	9.2	–	6.0	–	< 1	–	–
*C. emeiensis**	1.3	–	10.2	–	8.0	–	8.1	–	< 1	–	–
*E. rongshuiensis**	–	1.1	–	8.0	–	6.0	–	5.0	–	> 1	–
*E. zayuensis**	1.3	–	10.2	–	8.4	–	6.0	–	> 1	–	–
*M. nigritubercle**	1.3	1.3	1.0	8.0	9.0	7.0	5.0	5.0	= 1	> 1	–
*M. yaoshanensis**	–	1.0	11.0	8.0	9.0	7.0	6.0	5.5	= 1	> 1	–
*T. albistriatus**	1.0	1.0	12.0	10.0	8.5	8.0	7.0	5.0	= 1	= 1	–
*T. albomaculatus**	–	1.0	–	9.0	–	8.5	–	5.5	–	= 1	–
*T. albomarginis**	–	1.4	–	6.0	–	6.0	–	5.0	–	= 1	–
*T. cenwanglaoshana***	1.6	–	9.0	–	10.5	–	6.0	–	< 1	–	–
*T. cliva**	–	1.0	–	7.2	–	7.5	–	5.5	–	= 1	3.0
*T. duolunensis**	1.6	1.2	9.0	7.0	8.0	6.0	6.0	5.0	= 1	> 1	2.6
*T. grossovalva***	1.5	–	11.0	–	13.0	–	7.0	–	–	–	3.5
*T. jiuwanshanensis***	1.6	1.5	11.0	8.0	12.0	10.0	6.0	5.0	= 1	> 1	–
*T. latipalpa**	1.7	–	10.0	–	7.5	–	7.0	–	= 1	–	–
*T. liuwanshanensis**	–	1.1	–	9.5	–	8.0	–	5.5	–	> 1	2.8
*T. qinlingensis***	1.6	1.5	11.0	10.0	13.0	11.0	6.5	5.5	< 1	= 1	3.0
*T. rectimargina**	1.0	–	11.0	–	8.0	–	7.0	–	> 1	–	3.3
*T. ruyuanensis**	1.5	1.5	11.0	9.0	9.0	7.0	7.0	5.0	> 1	> 1	2.8
*T. xianensis***	1.1	–	8.5	8.0	7.0	6.0	6.0	5.0	< 1	–	2.5
*T. xinchengensis***	–	1.0	11.0	–	9.0	–	7.0	–	–	> 1	3.0
*T. yunlongensis**	–	1.4	–	7.5	–	6.0	–	6.0	–	= 1	2.6
*T. zhoushanensis**	1.1	1.0	9.9	7.8	8.5	6.3	6.2	6.0	= 1	= 1	3.0

Note: V/E: Vertex wide/eye diameter; LB: Length of body; LP: Length of pronotum; LF: Length of hind femur; M/T: Width of midfemur/width of visible part of tegmina; LH/WH: Length of hind femur/width of hind femur. –: not described or illustrated in the original descriptions of species. *: brachypronotal; **: pauropronotal.

Diagnosis. *Tetrix japonica* can be differentiated from all the other Tetrigidae of China, North Korea, and Japan by the following set of the traits: the head not exserted above the upper level of the pronotum (strongly exserted in *Euparatettix*, *Ergatettix*, and *Bannatettix*); in lateral view, frontal ridge and vertex forming an obtuse angle (in lateral view, frontal ridge and vertex forming rounded shape in *Coptotettix* and *Hedotettix*); fastigium of vertex in lateral view angulate, not much produced in front of eyes (fastigium of vertex in lateral view oblique, considerably produced in front of eyes in *Clinotettix*); anterior margin of the vertex truncated, weakly arcuate (strongly angular in *Tetrix bipunctata*, *Tetrix subulate*, *Tetrix simulans*); anterior margin of pronotum truncate, weakly angular protruding (strongly angular in *Tetrix tartara*); tegmenula and alae present (absent in *Formosatettix*, *Aalatettix*); alae > 2 × longer than tegmenula (short in *Tetrix bipunctata*, *Alulatettix*).

Tetrix japonica is most similar to *Tetrix tenuicornis* (Sahlberg, 1893) from the Western Palearctic from which it differs in its pronotum slightly tectiform, median carina of pronotum low, not lamellar (vs pronotum distinctly tectiform, median carina of pronotum high, lamellar in *T. tenuicornis*).

A catalog of synonyms. (map of all the type localities of all the synonyms in Fig. 16).

Coptotettix circinihumerus Zheng & Deng, 2004a: 79 [description] (holotype ♀, China: Guangxi prov., Nanda County, in IZSNU, examined); Zheng 2005a: 237; Deng Zheng and Wei 2007a: 214; Zheng et al. 2013: 22; Deng 2016: 197. syn. nov. (Fig. 3A–C).

Coptotettix emeiensis Zheng, Lin & Zhang, 2012: 2554 [description] (holotype ♀, China: Sichuan prov., Emeishan City, in IZSNU, examined); Zheng et al. 2013: 22; Deng 2016: 197. syn. nov. (Fig. 3D–F).

Euparatettix rongshuiensis Zheng, 2005a: 387 [description] (holotype ♂, China: Guangxi prov., Rongshui County, in IZSNU, examined); Zheng 2005b: 99; Deng Zheng and Wei 2007a: 444; Deng 2016: 294. syn. nov. (Fig. 4A–C)

Euparatettix zayuensis Zheng, Zeng & Ou, 2011: 387 [description] (holotype ♀, China: Xizang autonomous region, Zayu County, Menkong, in IZSNU, examined); Deng 2016: 293. syn. nov. (Fig. 4D–F).

Macromotettix nigritubercle Zheng & Jiang, 2006: 141[description] (holotype ♀, China: Guangxi prov., Fusui County, Bapan, in IZSNU, examined); Deng et al. 2007a: 136; Deng 2016: 135; Deng, Xin & Chen, 2018: 423. syn. nov. (Fig. 5A–C).

Macromotettix yaoshanensis Zheng & Jiang, 2000: 403 [description] (holotype ♂, China: Guangxi prov., Jinxiu County, Liula, in IZSNU, examined); Zheng 2005a: 143; Deng et al. 2007a: 132; Deng 2016: 130; Deng et al. 2018: 423. syn. nov. (Fig. 5D–F).

Tetrix albistriatus Yao & Zheng, 2006: 824 [description] (holotype ♂, China: Yunnan prov., Pingbian County, Daweishan, in IZSNU, examined); Deng 2016: 245. syn. nov. (Fig. 6A–C).

Tetrix albomaculatus Zheng & Jiang, 2006: 142 [description] (holotype ♂, China: Guangxi prov., Fusui County, Bapan, in IZSNU, examined); Deng et al. 2007a: 286; Deng 2016: 242. syn. nov. (Fig. 6D–F).

Tetrix albomarginis Zheng & Nie, 2005: 582 [description] (holotype ♂, China: Yunnan prov., Dali County, Cangshan, in IZSNU, examined); Deng et al. 2007a: 300; Deng 2016: 245. syn. nov. (Fig. 7A–C).

Tetrix cenwanglaoshana Zheng, Jiang & Liu, 2005: 181 [description] (holotype ♀, China: Guangxi prov., Tianlin County, Cenwanglaoshan, in IZSNU, examined). syn. nov. (Fig. 7D–F).

Tetrix cliva Zheng & Deng, 2004b: 97 [description] (holotype ♂, China: Guangxi prov., Luocheng County, in IZSNU, examined); Zheng 2005a: 322; Deng et al. 2007a: 291a; Deng 2016: 251 (*Tetrix cliva* Zheng & Deng, 2004 = *Tetrix ruyuanensis* Liang, 1998, proposed in unpublished PhD Dissertation). syn. nov. (Fig. 8A–C).

Tetrix duolunensis Zheng, 1996: 178 [description] (holotype ♀, China: Inner Mongolia autonomous region, Duolun County, in IZSNU, examined); Zheng 2005c: 106; Deng 2016: 244. syn. nov. (Fig. 8D–F).

Tetrix grossovalva Zheng, 1994: 147 [description] (holotype ♀, China: Jilin prov., Fongman County, Songhuahu, in IZSNU, examined); Liang and Zheng 1998: 148; Zheng 2005c: 99; Deng 2016: 218. syn. nov. (Fig. 9).

Tetrix jiuwanshanensis Zheng, 2005a: 274 [description] (holotype ♀, China: Guangxi prov., Rongshui County, in IZSNU, examined); Zheng 2005c: 100; Deng et al. 2007a: 250; Deng 2016: 220. syn. nov. (Fig. 10).

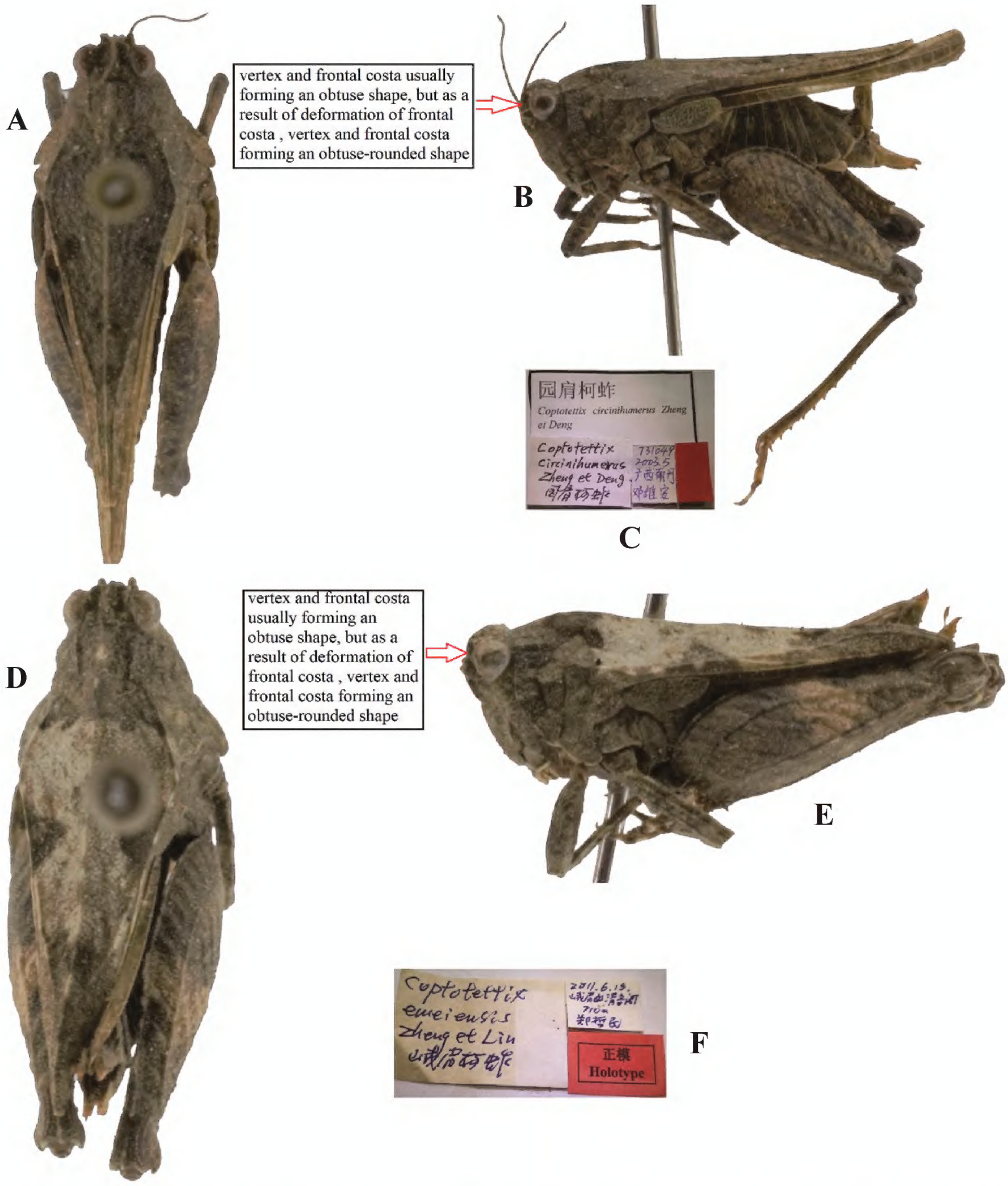

A
vertex and frontal costa usually forming an obtuse shape, but as a result of deformation of frontal costa , vertex and frontal costa forming an obtuse-rounded shape
B
园肩柯蚱
Coptotettix circinhumerus Zheng et Deng
Coptotettix Circinhumerus Zheng et Deng
C
D
vertex and frontal costa usually forming an obtuse shape, but as a result of deformation of frontal costa , vertex and frontal costa forming an obtuse-rounded shape
E
Coptotettix emeiensis Zheng et Liu
正模
Holotype
F

Figure 3. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Coptotettix circinihumerus* Zheng & Deng, 2004, syn. nov. **A** dorsal view **B** lateral view **C** labels **D–F** holotype of *Coptotettix emeiensis* Zheng, Lin & Zhang, 2012, syn. nov. **D** dorsal view **E** lateral view **F** labels.

Tetrix latipalpa Cao & Zheng, 2011: 739 [description] (holotype ♂, China: Sichuan prov., Emeishan County, Mt. Emei, in IZSNU, examined); Deng 2016: 249. syn. nov. (Fig. 11A–C).

Tetrix liuwanshanensis Deng, Zheng & Wei, 2007b: 294 [description] (holotype ♂, China: Guangxi prov., lingshan County, Liuwanda Mountain, in IZSNU, examined); Deng et al. 2007a: 277; Deng 2016: 238. syn. nov. (Fig. 11D–F).

Figure 4. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Euparatettix rongshuiensis* Zheng, 2005, syn. nov. **A** lateral view (The pin passes through the right side of the thorax from the shoulder of pronotum, which tends to push the pronotum down. This elevates the previously non-protruding head) **B** dorsal view **C** labels **D–F** holotype of *Euparatettix zayuensis* Zheng, Zeng & Ou, 2011, syn. nov. **D** lateral view (The pin passes through the right side of the thorax from the shoulder of pronotum, which tends to push the pronotum down. This elevates the previously unprotruding head) **E** dorsal view **F** labels.

Figure 5. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Macromotettix nigritubercle* Zheng & Jiang, 2006, syn. nov. **A** lateral view **B** dorsal view **C** labels **D–F** holotype of *Macromotettix yaoshanensis* Zheng & Jiang, 2000, syn. nov. **D** lateral view **E** dorsal view **F** labels.

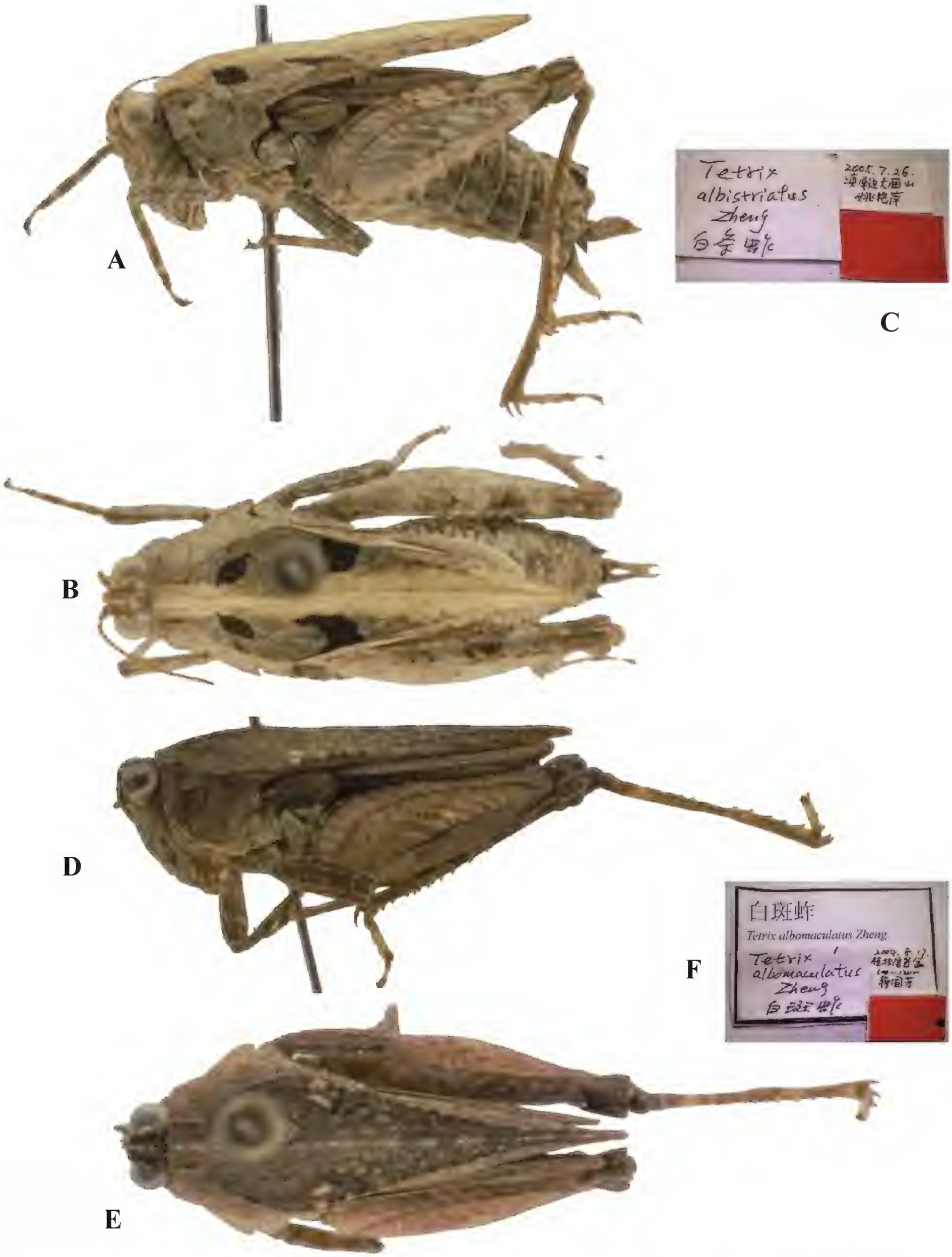
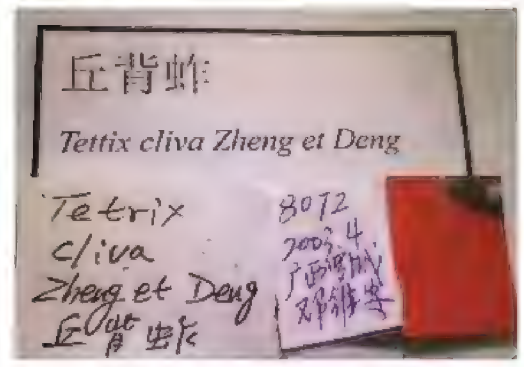
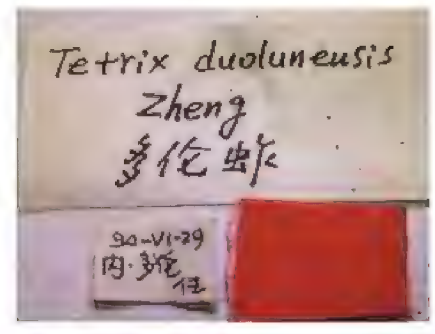


Figure 6. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Tetrix albistriatus* Yao & Zheng, 2006, syn. nov. **A** lateral view **B** dorsal view **C** labels **D–F** holotype of *Tetrix albomaculatus* Zheng & Jiang, 2006, syn. nov. **D** lateral view **E** dorsal view **F** labels.

Figure 7. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Tetrix albomarginis* Zheng & Nie, 2005, syn. nov. **A** dorsal view **B** lateral view **C** labels **D–F** holotype of *Tetrix cenwanglaoshana* Zheng, Jiang & Liu, 2005, syn. nov. **D** lateral view **E** dorsal view **F** labels.



C



F

Figure 8. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Tetrix cliva* Zheng & Deng, 2004, syn. nov. **A** dorsal view **B** lateral view **C** labels **D–F** holotype of *Tetrix duolunensis* Zheng, 1996, syn. nov. **D** dorsal view **E** lateral view **F** labels.

Figure 9. *Tetrix japonica* (Bolívar, 1887). Holotype of *Tetrix grossovalva* Zheng, 1994, syn. nov. **A** lateral view **B** dorsal view **C** labels.

Tetrix qinlingensis Zheng, Huo & Zhang, 2000: 238 [description] (holotype ♀, China: Shaanxi prov., Foping County, Zhongzui, in IZSNU, examined); Zheng 2005a: 275; Deng et al. 2007a: 251; Deng 2016: 220. syn. nov. (Fig. 12A, B).

Tetrix rectimargina Zheng & Jiang, 2004: 3 [description] (holotype ♀, China: Guangxi prov., Tian'e County, Buliu River, in IZSNU, examined); Zheng 2005a: 308; Deng et al. 2007a: 273; Deng 2016: 234. syn. nov. (Fig. 12D–F).

Tetrix ruyuanensis Liang, 1998: 174 [description] (holotype ♀, China: Guangdong prov., Ruyuan County, Tianjingshan, in BMSYU, not examined); Zheng 2005a: 307; Deng et al. 2007a: 303; Deng 2016: 251. syn. nov. (Fig. 13A, B).

Tetrix xianensis Zheng, 1996: 177 [description] (holotype ♀, China: Shaanxi prov., Xi'an City, Shaanxi Normal University, in IZSNU, examined); Zheng 2005a: 283; Deng 2016: 226. syn. nov. (Fig. 13D–F).

Tetrix xinchengensis Deng, Zheng & Wei, 2007a: 289[description] (holotype ♂, China: Guangxi prov., Xincheng County, in IZSNU, examined); Deng 2016: 242. syn. nov. (Fig. 14A, B).

Tetrix yunlongensis Zheng & Mao, 2002: 91[description] (holotype ♂, China: Yunnan prov., Yunlong County, in IZSNU, examined); Zheng 2005a: 311; Deng et al. 2007a: 275; Deng 2016: 236. syn. nov. (Fig. 14D, F).

Figure 10. *Tetrix japonica* (Bolívar, 1887). *Tetrix jiuwanshanensis* Zheng, 2005, syn. nov. **A** holotype, lateral view **B** holotype, dorsal view **C, F** labels **D** allotype, lateral view **E** allotype, dorsal view.

Figure 11. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Tetrix latipalpa* Cao & Zheng, 2011, syn. nov. **A** dorsal view **B** lateral view **C** labels **D–F** holotype of *Tetrix liuwanshanensis* Deng, Zheng & Wei, 2007, syn. nov. **D** lateral view **E** dorsal view **F** labels.

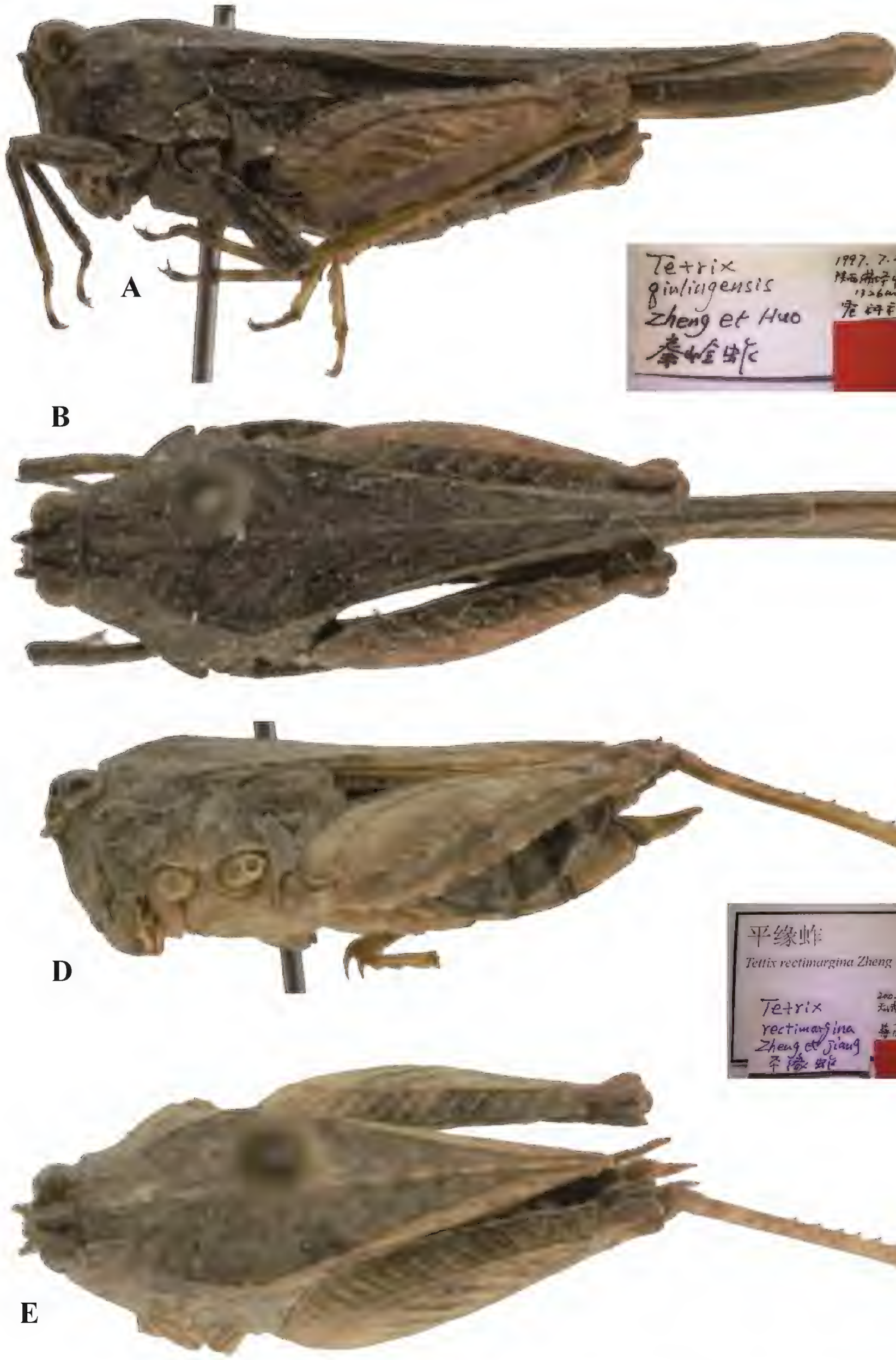


Figure 12. *Tetrix japonica* (Bolívar, 1887) **A–C** holotype of *Tetrix qinlingensis* Zheng, Huo & Zhang, 2000, syn. nov. **A** lateral view **B** dorsal view **C** labels **D–F** holotype of *Tetrix rectimargina* Zheng & Jiang, 2004, syn. nov. **D** lateral view **E** dorsal view **F** labels.

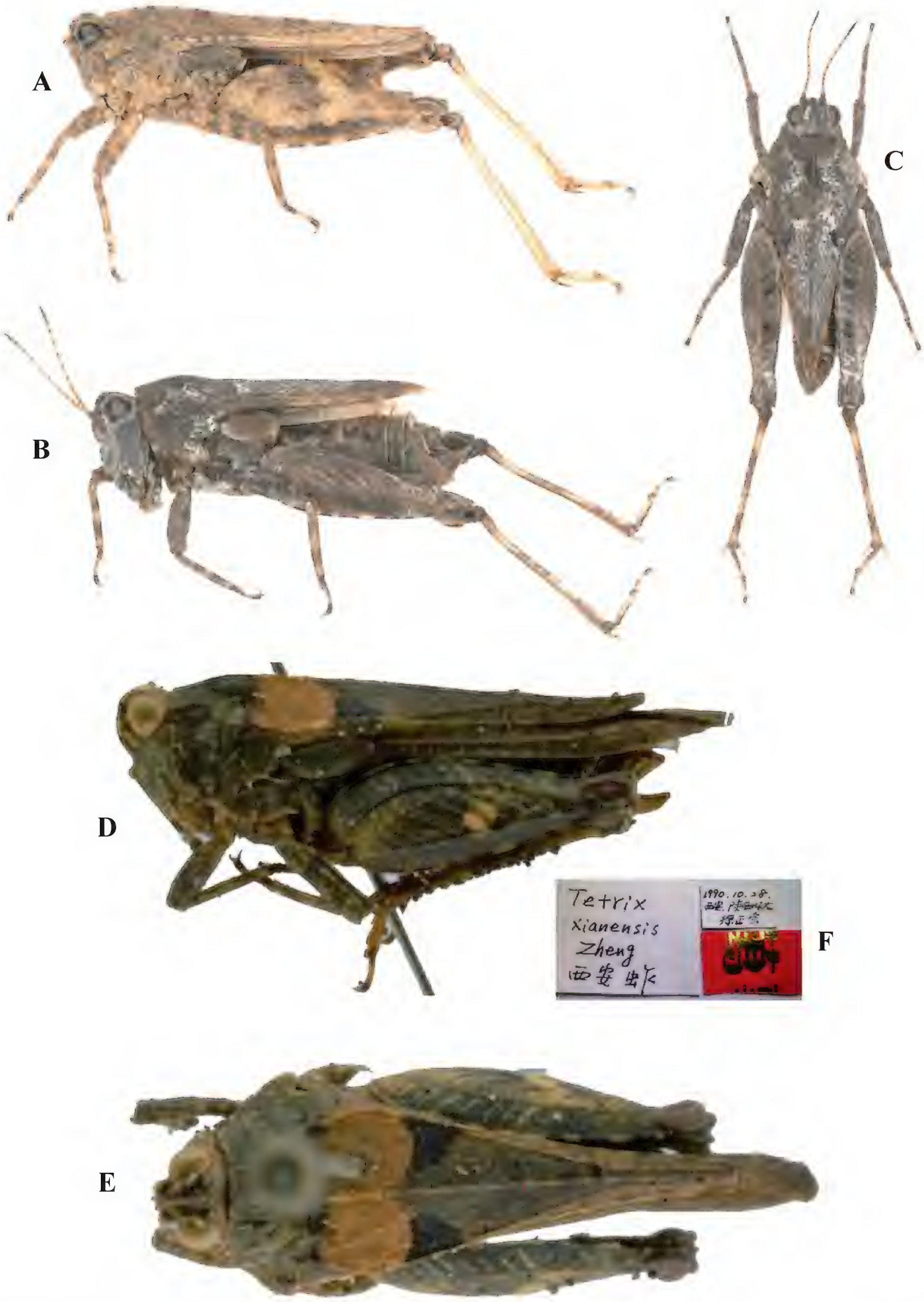


Figure 13. *Tetrix japonica* (Bolívar, 1887) **A–C** topotype of *Tetrix ruyuanensis* Liang, 1998, syn. nov. **A** lateral view, pronotum with nearly straight median carina **B** lateral view, pronotum with arcuate median carina before shoulders **C** dorsal view **D–F** holotype of *Tetrix xianensis* Zheng, 1996, syn. nov. **D** lateral view **E** dorsal view **F** labels.

Tetrix zhoushanensis Gao, Liu & Yin, 2022: 347 [description] (holotype ♂, China: Zhejiang prov., Zhoushan City, in MHU, not examined). syn. nov. (Fig. 15).

Type material examined. Type material of *Tetrix japonica* was examined from the photographs of the syntype (♀, brachypronotal and brachypterous specimen, in MHNG, photographs by Josef Tumbrinck), available online in OSF (Fig. 2A).

Other material of *Tetrix japonica* examined. 11♂23♀, China: Sichuan prov., Emeishan City, 29 July 2018, in EMHU; 17♂13♀, China: Xizang, Zayu County, 25 June 2019, in EMHU; 33♂19♀, China: Guangxi prov., Fusui County, Bapan, 17 August 2014, in EMHU; 24♂23♀, China: Guangxi prov., Jinxiu County, 26 July 2021, in EMHU; 37♂20♀, China: Yunnan prov., Pingbian County, Daweishan, 26 July 2020, in EMHU; 55♂27♀, China: Guangxi prov., Tianlin County, Cenwanglaoshan, 25 May 2018, in EMHU; 52♂38♀, China: Guangxi prov., Longzhou County, nonggang, 18 July 2023, in CLSGNU; 47♂58♀, China: Guangxi prov., Luocheng County, Jiuwanshan, 21 August 2022, in EMHU; 7♂8♀, China: Inner Mongolia autonomous region, Duolun County, 09 August 2019, in EMHU; 27♂32♀, China: Guangxi prov., Rongshui County, 06 August 2003, in EMHU; 17♂21♀, China: Guangxi prov., lingshan County, Liuwanda Mountain, 24 August 2022, in CLSGNU; 20♂8♀, China: Shaanxi prov., Foping County, 28 July 2022, in CLSGNU; 11♂15♀, China: Guangdong prov., Ruyuan County, Tianjingshan, 20 August 2022, in CLSGNU; 17♀10♂, China: Liaoning prov., Benxi County, Tanggou, 27 July 2023 in CLSGNU; 22♀22♂, China: Jilin prov., Changbai County, Changbai, 31 July 2023 in CLSGNU; 14♀23♂, China: Heilongjiang prov., Mudanjiang City, Mudanfen, 3 August 2023 in CLSGNU; 29♀13♂, China: Heilongjiang prov., Yichun City, Jiayin County, 6 August 2023 in CLSGNU; 22♀11♂, China: Heilongjiang prov., Xinlin County, Xinlin, 9 August 2023 in CLSGNU; 26♀43♂, China: Inner Mongolia prov., Tuquan County, Taihe,12 August 2023 in CLSGNU; 33♀50♂, China: Inner Mongolia prov., Horqin Right Middle Banner, Wutaiyingzi, 13 August 2023 in CLSGNU.

Type material of the synonyms examined.

Coptotettix circinihumerus: ♀, holotype (Fig. 3A–C), China: Guangxi prov., Nandan County, Songhuahu, May 2003, in IZSNU.

Coptotettix emeiensis: ♀, holotype (Fig. 3D–F), China: Sichuan prov., Emeishan City, 13 June 2011, in IZSNU.

Euparatettix rongshuiensis: ♂, holotype (Fig. 4A–C), China: Guangxi prov., Rongshui County, 06 August 2003, in IZSNU.

Euparatettix zayuensis: ♀, holotype (Fig. 4D–F), China: Xizang, Zayu County, Menkong, 04–05 July 2005, in IZSNU.

Macromotettix nigritubercle: ♀, holotype (Fig. 5A–C) and 1♂ paratype, China: Guangxi prov., Fusui County, Bapan, 17 August 2004, in IZSNU.

Macromotettix yaoshanensis: ♂, holotype (Fig. 5D–F), China: Guangxi prov., Jinxiu County, Liula, 06 July 1997, in IZSNU.

Tetrix albistriatus: ♀, holotype (Fig. 6A–C) and 1♂3♀ paratypes, China: Yunnan prov., Pingbian County, Daweishan, 26 July 2005, in IZSNU.

Tetrix albomaculatus: ♂, holotype (Fig. 6D–F), China: Guangxi prov., Fusui County, Bapan, 17 August 2004, in IZSNU.

Tetrix albomarginis: ♂, holotype (Fig. 7A–C), China: Yunnan prov., Dali County, Cangshan, 09 August 2004, in IZSNU.

Tetrix cenwanglaoshana: ♀, holotype (Fig. 7D–F), China: Guangxi prov., Tianlin County, Cenwanglaoshan, 31 May 2002, in IZSNU.

Figure 14. *Tetrix japonica* (Bolívar, 1887) **A–C** topotype of *Tetrix xinchengensis* Deng, Zheng & Wei, 2007, syn. nov. **A** lateral view **B** dorsal view **C** labels **D–F** holotype of *Tetrix yunlongensis* Zheng & Mao, 2002, syn. nov. **D** lateral view **E** dorsal view **F** labels.

Figure 15. *Tetrix japonica* (Bolívar, 1887). Holotype of *Tetrix zhoushanensis,* Gao, Liu & Yin, 2022, syn. nov. **A** dorsal view **B** lateral view (photo Gao et al.).

Tetrix cliva: ♂, holotype (Fig. 8A–C), China: Guangxi prov., Luocheng County, April 2003, in IZSNU.

Tetrix duolunensis: ♀, holotype (Fig. 8D–F) and 5♂7♀ paratypes, China: Inner Mongolia autonomous region, Duolun County, 29 June 1994, in IZSNU.

Tetrix grossovalva: ♀, holotype (Fig. 9A–C), China: Jilin prov., Fongman County, Songhuahu, 19 July 1990, in IZSNU.

Tetrix jiuwanshanensis: ♀, holotype (Fig. 10) and 1♂ paratype, China: Guangxi prov., Rongshui County, 06 August 2003, in IZSNU.

Tetrix latipalpa: ♂, holotype (Fig. 11A–C), China: Sichuan prov., Emeishan County, Mt. Emei, 16 August 2010, in IZSNU

Tetrix liuwanshanensis: ♂, holotype (Fig. 11D–F) and 1♂ paratype, China: Guangxi prov., lingshan County, Liuwanda Mountain, 24 August 2005, in IZSNU.

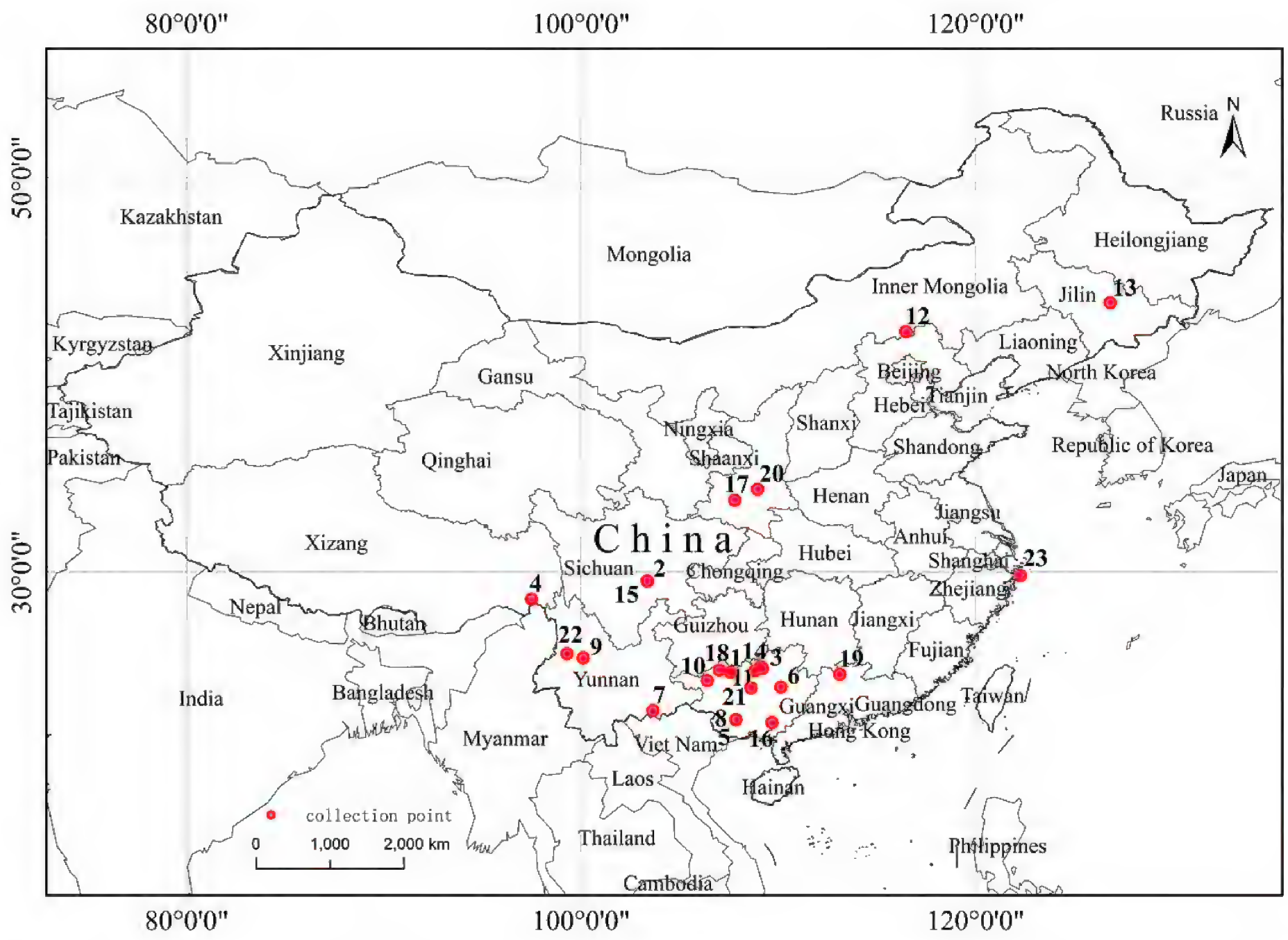


Figure 16. Distribution map of *Tetrix japonica* with all type localities of all the synonyms. 1 *C. circinihumerus*; 2 *C. emeiensis*; 3 *E. rongshuiensis*; 4 *E. zayuensis*; 5 *M. nigritubercle*; 6 M. yaoshanensis; 7 *T. albistriatus*; 8 *T. albomaculatus*; 9 *T. albomarginis*; 10 *T. cenwanglaoshana*; 11 *T. cliva*; 12 *T. duolunensis*; 13 *T. grossovalva*; 14 *T. jiuwanshanensis*; 15 *T. latipalpa*; 16 *T. liuwanshanensis*; 17 *T. qinlingensis*; 18 *T. rectimargina*; 19 *T. ruyuanensis*; 20 *T. xianensis*; 21 *T. xinchengensis*; 22 *T. yunlongensis*; 23 *T. zhoushanensis*.

Tetrix qinlingensis: ♀, holotype (Fig. 12A–C) and 1♂1♀ paratypes, China: Shaanxi prov., Foping County, Zhongzui, 24 July 1997, in IZSNU.

Tetrix rectimargina: ♀, holotype (Fig. 12D–F), China: Guangxi prov., Tian'e County, Buliu River, 05 August 2002, in IZSNU.

Tetrix xianensis: ♀, holotype (Fig. 13C–E), China: Shaanxi prov., Xian City, 28 October 1990, in IZSNU.

Tetrix xinchengensis: ♂, holotype (Fig. 14A–C), China: Guangxi prov., Xincheng County, 14 July 2005, in IZSNU.

Tetrix yunlongensis: ♂, holotype (Fig. 14D–F), China: Yunnan prov., Yunlong County, 03 May 1998, in IZSNU.

Justification of the synonymies. Holotype of *Coptotettix circinihumerus* (Fig. 3A–C) from Guangxi and holotype of *Coptotettix emeiensis* (Fig. 3D–F) from Sichuan have a deformed frontal costa, and vertex and frontal costa forming an obtuse-rounded aspect in profile. These two taxa were misidentified as members of the genus *Coptotettix*: *Coptotettix circinihumerus* has a widened vertex, a low pronotal median carina; antennal grooves inserted between inferior margins of compound eyes; hind wings extending beyond the apex of the pronotum; ventral margins of middle femora are slightly undulated. *Coptotettix emeiensis* is charac-

terized by width of vertex between eyes 1.3 × wider than width of a compound eye; antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum slightly arch-like before the shoulders and straight behind the shoulders in profile; hind wings nearly reach the apex of of the pronotum. *Coptotettix circinihumerus* and *Coptotettix emeiensis* are completely consistent with the morphology of brachypronotal and brachypterous individuals of *T. japonica*.

Euparatettix rongshuiensis (Fig. 4A–C) from Guangxi was described on the basis of a single male holotype. The holotype has a deformed head, and the head is slightly exserted above the upper level of the pronotum. However, it is characterized by frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum low and full length entire, in profile, slightly straight; ventral margins of middle femora straight; hind wings slightly surpassing apex of hind pronotal process. *Euparatettix zayuensis* (Fig. 4D–F) from Xizang was described based on two female specimens. The holotype has a deformed head, and the head is slightly exserted above the upper level of the pronotum. But it has a widened vertex, a low pronotal median carina, straight and widened middle femora. These two taxa were misidentified as members of the genus *Euparatettix*. *E. rongshuiensis*, and *E. zayuensis* appear to be conspecific with *T. japonica* (brachypronotal and brachypterous individuals).

Macromotettix nigritubercle (Fig. 5A–C) from Guangxi represents a synonym of *T. japonica*. It is the same as *T. japonica* (brachypronotal and brachypterous forms) in all of the characters except for the slightly obliquely truncate posterior angles of the lateral lobes of the pronotum. The slightly truncate posterior angles of lateral lobes of pronotum fit the known variability of *T. japonica*. Examination of *Macromotettix yaoshanensis* (Fig. 5D–F) from Guangxi, shows that this specimen is a brachypronotal and brachypterous *T. japonica*. It is characterized by head and eyes not exserted above pronotal surface; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum low and full length entire; hind wings slightly surpassing apex of hind pronotal process. The specimen also has interhumeral carinae between shoulders, while the interhumeral carinae are inconspicuous and small.

Tetrix albistriatus (Fig. 6A–C) from Yunnan, which completely fits the morphology of brachypronotal and brachypterous individuals of *T. japonica*, also has a white stripe on the median carina of the pronotum. The two taxa are conspecific and characterized by a frontal ridge and vertex forming an obtuse angle; median carina of pronotum nearly straight in profile, slightly arcuate in forepart; lower margins of mid femora slightly straight, width of mid femora equal to width of tegmina in females; hind wings not reaching the apex of the hind pronotal process.

Tetrix albomaculatus (Fig. 6D–F) from Guangxi was described based on a single male holotype. This specimen representing a brachypronotal and brachypterous *T. japonica*, has interhumeral carina between the shoulders and white spots behind the shoulders. It is characterized by head and eyes not exserted above pronotal surface; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; lower margins of mid femora straight, width of mid femora equal to width of tegmina in females. *Tetrix albomarginis* (Fig. 7A–C) from Yunnan was also described based on a single male holotype. This specimen is similar to the morphology of brachypronotal and brachypterous individuals of *T. japonica*, and has white

pronotal margins and a slightly elevated median carina of the pronotum. But it has a widened vertex, a low pronotal median carina, straight ventral margins of middle femora, as well as shortened pronotum and hind wings.

Tetrix cenwanglaoshana (Fig. 7D–F) from Guangxi was described based on a single female holotype. It is conspecific with *T. japonica* (pauropronotal individuals) and has a widened vertex, frontal ridge and vertex forming an obtuse angle in profile, low and full length entire pronotal median carina, as well as extended hind wings and pronotum.

Tetrix cliva (Fig. 8A–C) from Guangxi was described based on a single male holotype. In the original description, the specific epithet *cliva* refers to the shape of the upper margin of the pronotum, in profile, with a triangular process before the shoulders. Examination of holotype showed that the shoulders of pronotum were compressed and were deformed before the shoulders to create a triangular protuberance. Other important traits are the same as *T. japonica*: it has straight ventral margins of middle femora, as well as shortened pronotum and hind wings; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes. Therefore, *T. cliva* is conspecific with *T. japonica* (brachypronotal and brachypterous individuals).

We examined the type series of *Tetrix duolunensis* (Fig. 8D–F) from Inner Mongolia. The anterior margin of the fastigium of the vertex was slightly arcuate and slightly surpassed the anterior margin of the eye in some individuals. However, most individuals completely fit the morphology of brachypronotal and brachypterous individuals of *T. japonica*. It has a widened vertex, straight frontal costa, low pronotal median carina, and extended hind wings and pronotum. Thus, *T. duolunensis* is considered to be a synonym of *T. japonica*.

Tetrix grossovalva (Fig. 9A–C) from Jilin was described based on a single female holotype that appears to be conspecific with *T. japonica* (pauropronotal individuals). It has a widened vertex, straight frontal costa, low and full length entire pronotal median carina, and extended hind wings and pronotum.

Tetrix jiuwanshanensis (Fig. 10) from Guangxi completely fits the morphology of pauropronotal individuals of *T. japonica*. These two taxa are conspecific and characterized by the frontal ridge and vertex forming an obtuse angle; width of vertex wider than width of an eye, 1.6 ×; median carina of pronotum nearly straight in profile, slightly arcuate in forepart; ventral margins of mid femora slightly undulated, width of mid femora equal to width of tegmina in females.

Tetrix latipalpa (Fig. 11A–C) from Sichuan was described based on a single male holotype. The holotype has a deformed pronotum, and the median carina is slightly elevated and slightly sinuate. It is characterized by the frontal ridge and vertex forming an obtuse angle; width of vertex wider than width of an eye 1.6 ×; ventral margins of mid femora straight, width of mid femora equal to width of tegmina in females; the hind wings distinctly surpass the apex of the hind pronotal process. It is conspecific with brachypronotal and brachypterous *T. japonica*.

Tetrix liuwanshanensis (Fig. 11D–F) from Guangxi completely fits the morphology of brachypronotal and brachypterous individuals of *T. japonica* except for the slightly obtuse anterior margin of the pronotum. The slightly obtuse anterior margin of the pronotum fits the known variability of *T. japonica*. It is characterized by width of vertex between eyes is 1.1 × the width of the compound eye; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum

slightly arcuate in forepart; ventral margins of mid femora straight, width of mid femora wider than width of tegmina.

Tetrix qinlingensis (Fig. 12A–C) from Shaanxi is conspecific with *T. japonica* (pauropronotal individuals). These two taxa are characterized by width of vertex between eyes wider than width of compound eye; frontal ridge and vertex forming an obtuse angle; median carina of pronotum nearly straight in profile, slightly arcuate in forepart; ventral margins of mid femora slightly undulated, width of mid femora slightly narrower than width of tegmina in female; hind pronotal process surpassing apex of hind femur; hind wings surpassing apex of hind pronotal process.

Tetrix rectimargina (Fig. 12D–F) from Guangxi was described based on a single female holotype. *Tetrix rectimargina* represents a synonym of *T. japonica*. It is the same as brachypronotal and brachypterous *T. japonica* in all the characters except for the narrow vertex (width of vertex between eyes is equal to the width of compound eye). The slightly narrow vertex fits the known variability of *T. japonica*.

Tetrix ruyuanensis (Fig. 13A–C) from Guangdong was described based on a single female holotype, according to the description of the species by Liang and Zheng (1998), *T. ruyuanensis* is very similar to brachypronotal and brachypterous individuals of *T. japonica*. The only difference is median carina of pronotum arcuate before shoulders in profile in *T. ruyuanensis* (vs median carina of pronotum nearly straight before shoulders in profile in *T. japonica*). Topotypes of *T. ruyuanensis* were examined, and it was found that some individuals have an arcuate median carina before shoulders (Fig. 13B). However, most individuals have a nearly straight median carina (Fig. 13A). Thus, *T. ruyuanensis* is considered to be a synonym of *T. japonica*.

Tetrix xianensis (Fig. 13D–F) from Shaanxi was described based on a single female holotype, and *T. xianensis* represents a synonym of *T. japonica*. It is the same as brachypronotal and brachypterous *T. japonica* in all the characters except for the slightly arcuate vertex and slightly extended hind wings and pronotum. The slightly arcuate vertex and slightly extended hind wings and pronotum fit the known variability of the species.

Tetrix xinchengensis (Fig. 14A–C) from Guangxi was described based on a single male holotype, and *T. xinchengensis* represents a synonym of *T. japonica*. It is the same as brachypronotal and brachypterous *T. japonica* in all of the characters except for the slightly extended hind wings and pronotum. Extended hind wings and pronotum are consistent with the known variability of *T. japonica*.

Tetrix yunlongensis (Fig. 14D–F) from Yunnan was described based on a single male holotype, and *T. yunlongensis* represents a synonym of *T. japonica*. It is the same as brachypronotal and brachypterous *T. japonica* in all morphological characters except for the slightly obtuse anterior margin of the pronotum. The slightly obtuse anterior margin of the pronotum is consistent with the known variability of *T. japonica*. It is characterized by width of vertex between eyes is 1.4 × the width of the compound eye; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum slightly arcuate in forepart; ventral margins of mid femora straight.

Type material of *Tetrix zhoushanensis* from Zhejiang was not examined, but according to the original description and photographs (Fig. 15) of the type

specimens in Gao et al. (2022), *Tetrix zhoushanensis* is identical to the morphology of brachypronotal and brachypterous individuals of *T. japonica*. *Tetrix zhoushanensis* has a narrower vertex (width of vertex between eyes is 1.1 × the width of the compound eye) than typical *T. japonica*, but this trait should be studied more in future in order to see if it has maybe a subspecies value. It is characterized by antennal grooves inserted between inferior margins of compound eyes; median carina of pronotum slightly arcuate in forepart; ventral margins of mid femora straight.

Discussion

Tetrix japonica is widely distributed in East Asia, and China, where is very common except in Hainan and Xinjiang. The People's Republic of China has a vast and complex ecological environment with an abundance of insect species. It has a huge diversity of Tetrigidae and has the most described species in the world (e.g., Liang and Zheng 1998, Zheng 2005a, Cigliano et al. 2023). However, 23 species are herewith synonymized with *T. japonica* because their descriptions were not based upon valid differences, but a wrongly assessed species variability, often caused by too few specimens being examined. Among the 23 synonyms, 11 synonyms (*E. rongshuiensis*, *T. cliva*, *T. latipalpa*, *T. albomaculatus*, *T. cenwanglaoshana*, *T. grossovalva*, *T. xinchengensis*, *T. rectimargina*, *Tetrix ruyuanensis*, *T. xianensis*, *T. yunlongensis*) were based on single specimens. One should be very careful when describing new Tetriginae species because few individuals can lead to wrong conclusions or a taxonomic inflation.

Additionally, some deformities were observed in the single-specimen species. The main causes of specimen deformities were recorded were two-fold. One was that the body was compressed by external forces during growth (*T. cliva*, *T. latipalpa*, *C. circinihumerus*, *C. emeiensis*). The other is that deformities were caused by humans during specimen preparation. For example, pygmy grasshopper specimens are usually dried and pinned. When inserting a pin into a specimen, the pin typically passes through the right side of the thorax from the shoulder of pronotum, which tends to push the pronotum down. This elevates the previously non-protruding heads such as in *E. rongshuiensis* and *E. zayuensis*.

Some pygmy grasshoppers are highly polymorphic in both colors and markings. *Tetrix japonica*, which occurs in both grass and sand microhabitats, exhibits large variations in body coloration and pronotum markings. Within a single population, the basal body coloration can vary from blackish brown to yellowish brown to pale grey. Some *T. japonica* are bi-colored, with whitish and blackish markings on the dorsal surface of the pronotum. In contrast, some *T. japonica* have no markings, whereas others have spots on the pronotum. The number, shape, and position of spots also varies among the spotted morphs (Tsurui et al. 2010). Therefore, in the classification of Tetrigoidea, and especially in Tetriginae: Tetrigini the spots on the dorsal pronotum are not a reliable taxonomic feature. In Batrachideinae and Metrodorinae, some group coloration is helpful (Tumbrinck and Skejo 2017; Kasalo et al. 2021; Itrac-Bruneau and Doucet 2023), but these groups are exceptions within Tetrigidae, not the rule. In the early classification of Tetrigoidea in China (Liang and Zheng 1998; Zheng 2005a), this character was often used as a taxonomic feature. As a result, *T. albistriatus*, *T. albomaculatus*, and *T. albomarginis* have been synonymized with *T. japonica*.

Dimorphism in wing length is known in many insect species, and in some species of pygmy grasshoppers, both the hind wings and the pronotum can be dimorphic (Deng 2021; Zhang et al. 2022). Because pygmy grasshoppers can vary in pronotum characters and length of the hind wings (Deng 2021; Zhang et al. 2022), the length of the hind wings and the pronotum cannot be used as taxonomic characters for classification of some species. However, in previous classifications of Tetrigoidea in China (e.g., Liang and Zheng 1998; Zheng 2005a; Deng et al. 2007a), these two characters were often used alone as diagnostic features; the dimorphism of these two characters was not considered. Therefore, misidentification of some species of *Tetrix* can readily occur and lead to synonyms, such as *T. cenwanglaoshana*, *T. grossovalva*, *T. jiuwanshanensis*, *T. qinlingensis*, and *T. xinchengensis*, which have all been here synonymized with *T. japonica*.

Similarly, *T. japonica* individuals can also exhibit variability in the shape of posterior angles of lateral lobes of pronotum and fastigium of vertex and anterior margin of pronotum, height median carina of pronotum, width of vertex between eyes, width of the middle femur, length of body, length of pronotum, and length of hind femur (Table 1). Therefore, these features alone cannot be used separately in taxonomic identification. Hence, when *T. japonica* is identified among other *Tetrix* species, we are strongly recommended using a combination of characters: head and eyes not exserted above pronotal surface; width of vertex between eyes generally wider than or sometimes equal to width of a compound eye; anterior margin of fastigium of vertex truncated or slightly arcuate and slightly surpassing anterior margin of eye; frontal ridge and vertex forming an obtuse angle; antennal grooves inserted between inferior margins of compound eyes; anterior margin of pronotum generally truncate; median carina of pronotum low and full length entire, in profile, slightly straight or slightly arch-like before the shoulders and straight behind the shoulders; ventral margins of middle femora straight or slightly undulated; with tegmina and hind wings developed, nearly reach apex of hind process or more.

The problematic taxonomy of *T. japonica* suggests that similar problems will occur in other species of *Tetrix*. This genus requires more research, especially, regarding interspecific and intraspecific variability.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

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Author ORCIDs

Ying Long https://orcid.org/0009-0003-8226-8958
Caili Teng https://orcid.org/0009-0008-2124-959X
Chaomei Huang https://orcid.org/0000-0003-1046-1348
Rongjiao Zhang https://orcid.org/0000-0001-5545-856X
Weian Deng https://orcid.org/0000-0002-8023-2498
Liliang Lin https://orcid.org/0000-0002-9972-4732

Data availability

All of the data that support the findings of this study are available in the main text.

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